AUTOMATIC TRANMISSION CONTROL

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Introduction

The introduction of the automatic transmission did this by offering a “no-muss, no-fuss” form of shifting. The earliest automobiles offered only manual transmissions, which were similar in principle to today’s stick-shift vehicles. The first automatic transmission was invented in 1921 by a Canadian steam engineer, Alfred Horner Munro. Munro designed his device to use compressed air rather than hydraulic fluid so it lacked power and never became sold commercially. General Motors then developed the first automatic transmission using hydraulic fluid in the 1930’s, and introduced the “Hydra-Matic” transmission in 1940.

The most significant changes/improvements in automatic transmission design to date are the number of forward gears transmissions now have and the switch from mechanically controlled to electronically controlled transmission operations. Mechanically controlled automatic transmissions have reached their limit in terms of future improvements while electronically (or computer) controlled automatic gearboxes have only touched the surface of the possibilities.

Global Market

Key players including Continental AG, Robert Bosch, BorgWarner, Delphi Technologies, Denso Corporation, Dana Limited, Infineon Technologies, Eaton, Allison Transmission Inc., and ZF Friedrichshafen account for major transmission control system market shares.

The global transmission control system market size was valued at $36.30 billion in 2018 and is projected to reach $58.61 billion by 2026, registering a CAGR of 6.3% from 2019 to 2026. Asia-Pacific accounted for the highest share in 2018 and is expected to be the highest contributor to the global market, in terms of revenue, during the transmission control system market forecast. Factors such as increasing demand for automatic transmission in vehicles and growing trend of autonomous vehicles is anticipated to propel the growth of the transmission control system market. However, high cost of transmission control system and its related components hinder the market growth. Furthermore, production of active shift control transmission is expected to provide remarkable growth opportunities for players operating in the transmission control system market.

Working

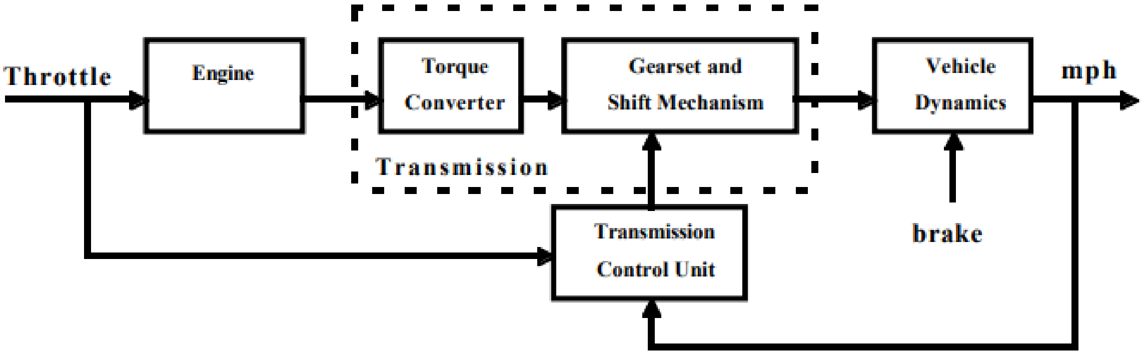
The engine contains a heavy central crankshaft cylinder that spins, which provides the power to turn the wheels. “Engine speed” is how fast the crankshaft spins, measured in revolutions per minute or “rpm.” Most engines make the majority of their power within a relatively narrow range of speeds, but driving the vehicle requires a wider range. The transmission is the vital link, increasing torque to accelerate away from a stop, or preventing the engine from working too hard at highway speeds. An automatic transmission uses sensors to determine when it should shift gears, and changes them using internal oil pressure. While there are numerous components stuffed into the transmission, and their actual operation is a bit more complicated than the simplified version presented here, the key components are the torque converter and planetary gearsets.

In order to shift gears, the transmission must be temporarily disconnected from the engine. On a manual transmission the driver does that by pushing in the clutch pedal, but on an automatic, it’s handled by the torque converter.

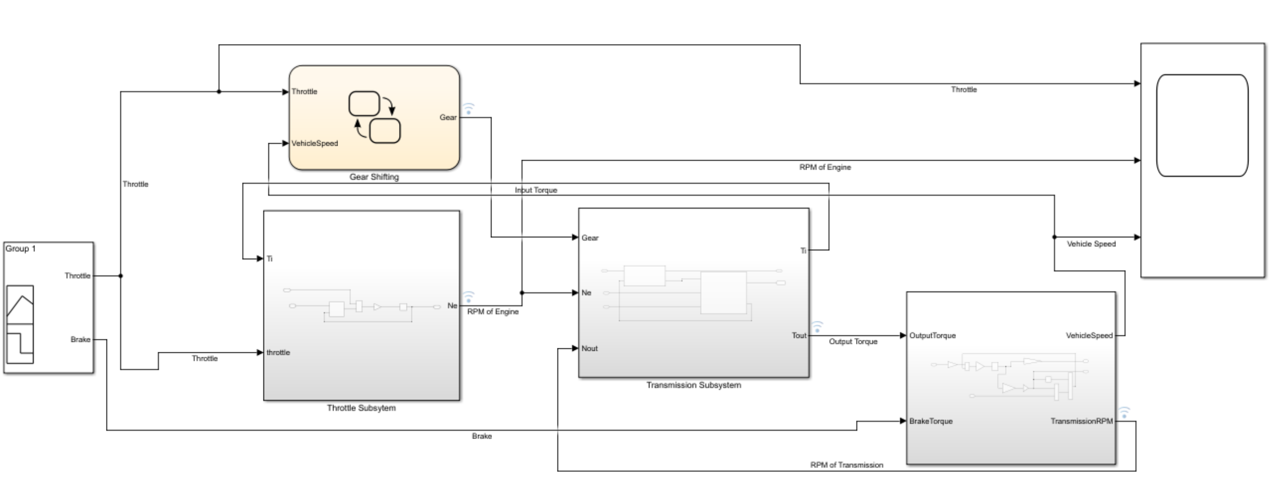
There are two fan-shaped components inside the torque converter, which is filled with transmission fluid: an impeller, which is attached to the engine’s crankshaft, and a turbine, attached to the transmission’s input shaft. As the engine turns the impeller, its blades move the fluid, which in turn causes the turbine to turn. The fluid moves in a closed loop. A third fan-shaped component, the stator, sits between the impeller and turbine and helps direct the fluid’s movement. As you push the throttle to speed up, the fluid moves the turbine faster to send more power through the transmission. As you slow down, the fluid’s movement slows, the turbine stops spinning, and the engine can sit and idle without stalling. Once that power has been transferred to the transmission’s input shaft, it’s time for the planetary gears to do their thing. The name comes from the way they’re arranged. A central gear is called the sun gear, while smaller planet gears revolve around it, held in a ring called a planet carrier. A large toothed ring gear surrounds them all and is meshed with the planetary gears in their carrier.

By creating different gear ratios, the transmission takes the power from the engine and increases or reduces it on its way to the output shaft, which sends power toward the wheels. In first gear, the engine is turning relatively slowly as the driver gradually pushes the throttle, so the transmission uses a low gear to multiply the torque going to the wheels to give them the power needed to accelerate. At highway speeds the transmission uses overdrive, when the transmission’s output speed is faster than what’s coming in from the engine, saving fuel and engine wear-and-tear.

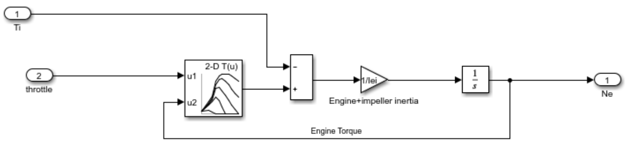
- <u>Simulink model</u>



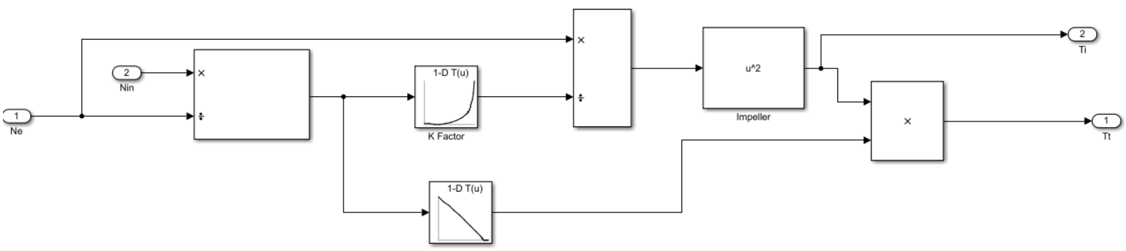
Overall model



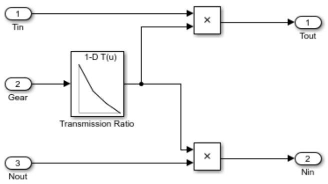
Model Made on Simulink



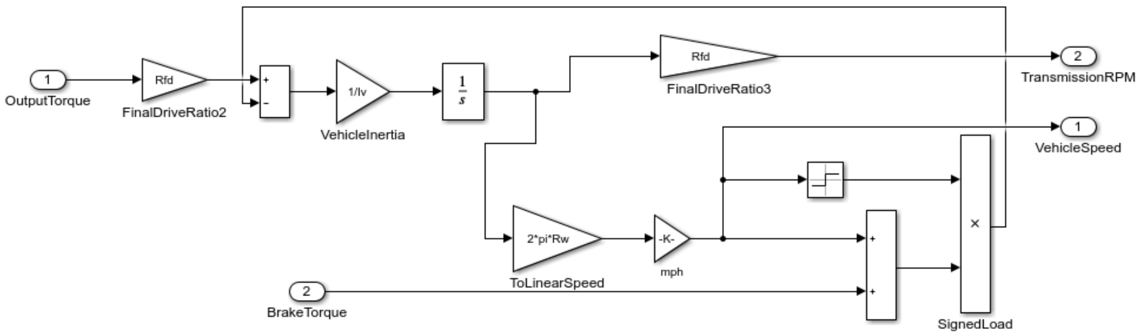
Throttle Subsystem



Torque Convertor block



Gear Ratio



Vehicle Subsystem

- Equations Used

$$I_{ei}\dot{N}_e = T_e - T_i$$

N_e = engine speed

I_{ei} = engine + impeller moment of inertia

T_e = f_1(throttle, N_e) = engine torque

T_i = impeller torque

$$T_{load} = \operatorname{sgn}(mph)(R_{load0} + R_{load2}\, mph^2 + T_{brake})$$

T_{load} = load torque

R_{load0}, R_{load2} = friction and aerodynamic drag coefficients

T_{brake} = brake torque

mph = vehicle linear velocity

$$I_v\dot{N}_w = R_{fd}(T_{out} - T_{load})$$

I_v = vehicle inertia

N_w = wheel speed

R_{fd} = final drive ratio

T_{load} = load torque $= f_5(N_w)$

$$T_i = (N_e / K)^2$$

$$K = f_2(N_{in} / N_e)$$

= capacity or K–factor

N_{in} = turbine (torque converter output) speed = transmission input speed

$$T_t = R_{TQ}T_i$$

= turbine torque

R_{TQ} = torque ratio $= f_3(N_{in} / N_e)$

$$R_{TR} = f_4(gear)$$

$$T_{out} = R_{TR}T_{in}$$

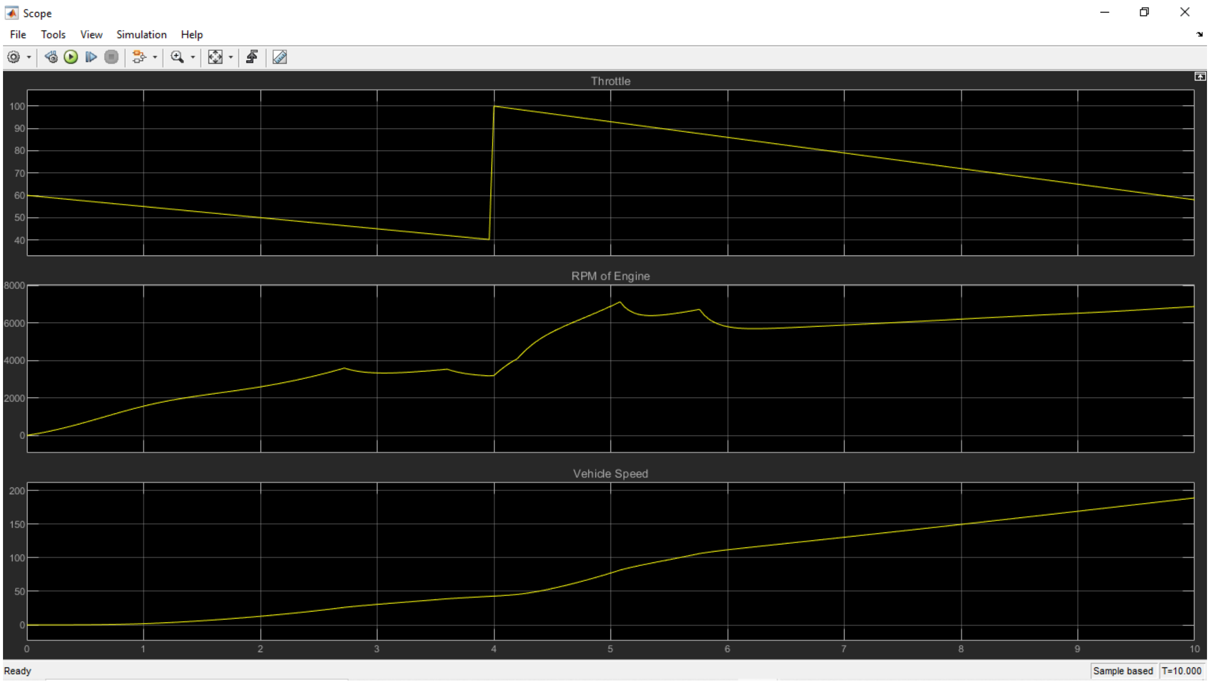
$$N_{in} = R_{TR}N_{out}$$

T_{in}, T_{out} = transmission input and output torque

N_{in}, N_{out} = transmission input and output speed

R_{TR} = transmission ratio

- Output Graph



Scope Output

Data Inspector Output

REFRENCES

1) https://auto.howstuffworks.com/automatic-transmission.htm
2) https://www.youtube.com/watch?v=Y1zbE21Pzl0
3) https://en.wikipedia.org/wiki/Transmission_control_unit
4) https://nptel.ac.in/courses/107/106/107106088/
5) Gear Shifting Chart Reference: https://www.mathworks.com/help/stateflow/ug/implement-an-automatic-transmission-gear-system-by-using-the-duration-operator.html